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ABSTRACT

This report discusses current research findings on the effects of peers and social interaction on academic achievement, then analyzes current national data, comparing results to the existing academic literature. Data from the 1998 National Assessment of Educational Progress (NAEP) database on reading were used to test the influences of peer attitudes on academic achievement. The NAEP examines academic achievement in various fields. It is administered to students in 4th, 8th, and 12th grade. Besides providing data on academics, it offers information on student, teacher, and administrator background. This study analyzes six factors: the effect of peers; race and ethnicity; parents' educational attainment; number of reading materials in the home; free or reduced price lunch participation; and gender. Results indicate that the peer effect is a strong influence on academic achievement, particularly in 4th grade. The significance of peer effect wanes by 8th grade. Family background characteristics also have an important influence. Both have effects that are independent from the effects of gender and race/ethnicity. An appendix presents the results of statistical models. (SM)

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# A Report of The Heritage Center For Data Analysis

## The Peer Effect on Academic Achievement Among Public Elementary School Students

Kirk A. Johnson, Ph.D.

CDA00-06 May 26, 2000

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# The Peer Effect on Academic Achievement Among Public Elementary School Students

Kirk A. Johnson, Ph.D.

What effect does a student's peer group have on academic achievement? Most academics recognize that a child's peers can have an impact on achievement, but the extent of that effect has been an open question. Further, few studies have focused on quantifying the academic outcomes associated with the peer effect.

Children are socialized by the people with whom they associate; through daily interaction over the course of many years, acceptable social customs are taught and fostered. Other children as well as adults can have a great impact on a broad range of issues in the child's life, including achievement in school. Understanding the way social interactions affect academic achievement is important for parents, educators, and policymakers. In particular, academic achievement and the often corresponding level of educational attainment[1] tend to predict the average earnings an individual may secure over a lifetime.[2] For this reason, isolating the peer effects on academic achievement can make a significant contribution to the public debate over education reform.

This report will briefly discuss the findings of current academic research on the effects of peers and social interaction on academic achievement. It will then analyze some of the most recently released national data and compare the results to the existing academic literature.

In analyzing the 1998 National Assessment of Educational Progress (NAEP) data on reading, this report concludes that:

- The peer effect is a particularly strong influence in academic achievement, especially for fourth graders.
- The peer effect is independent of other factors such as race, ethnicity, gender, income, and other background variables.
- Family background factors such as household environment and parental education also play an important role in explaining achievement in both the fourth and eighth grades.

1. Academic achievement is often measured by performance on standardized tests; educational attainment represents the level of total education reached by an individual (i.e., high school degree, bachelor's degree, or advanced/professional degree).
2. U.S. Bureau of the Census, "Education: The Ticket to Higher Earnings," *Statistical Brief* 93–7, April 1993, at *http://www.census.gov/apsd/www/statbrief/sb93_7.pdf*. See also U.S. Bureau of the Census, "More Education Means Higher Career Earnings," *Statistical Brief* 94–17, August 1994, at *http://www.census.gov/apsd/www/statbrief/sb94_17.pdf*.

## BACKGROUND

Researchers have been discussing the link between social interactions among peers in school and academic outcomes for over 40 years.[3] The extensive literature notes that a child's peer group influences social and academic development and that these influences begin at the very start of formal education.[4] Influences and motivations for all kinds of children's behavior, including study habits and personal academic development, come not only from their peers, but also from their parents, teachers, and others with whom they come into close contact.[5] Because of the sheer amount of time the typical child spends each day with his or her friends, the peer influence on a child can be substantial.

Two major issues in the literature on the peer effect merit special mention here: changes in the effect of peers over time and cultural patterns penalizing academic achievement.

First, some academics argue that peer effects become more important as time passes, peaking somewhere during adolescence.[6] At the same time, children must foster positive peer groups early in order to become well-adjusted adolescents and adults.[7] Having friends in school allows the child to learn a host of skills: group interaction, conflict resolution, and trust building, among others.[8] Without positive peer group interactions, serious social problems may develop. Peer rejection in early childhood and early adolescence, for example, is a good predictor of social and academic problems later.[9]

The predictive power is generally indirect; consider, for example, the case of positive peer relationships. Peer approval leads to a pro-social behavior in many areas of a child's life, including academics.[10] This in turn will tend to affect the self-esteem of the child, which has other social consequences.[11] The literature on this issue is extensive, and a number of texts have been written on the subject.[12]

The second issue is more troubling. Some literature suggests that there is a cultural pattern within the African–American and Latino communities whereby students disparage academic achievement because it is perceived as "selling out"[13] or "acting white."[14] In other words, children in this culture are often ostracized for conforming to the educational system. This issue is particularly troubling since it may well explain the differences in aca-

3. James Coleman, *Social Climates in High Schools* (Washington, D.C.: U.S. Government Printing Office, 1961).
4. Anthony Pellegrini, "Kindergarten Children's Social-Cognitive Status as a Predictor of First-Grade Success," *Early Childhood Research Quarterly*, Vol. 7 (1992), pp. 565–577.
5. Kathryn Wentzel, "Social Relationships and Motivation in Middle School: The Role of Parents, Teachers, and Peers," *Journal of Educational Psychology*, Vol. 90 (1998), pp. 202–209.
6. See Lawrence Steinberg, *Beyond the Classroom: Why School Reform Has Failed and What Parents Need to Do* (New York: Touchstone, 1996), p. 141, and H. Walter, R. Vaughn, and A. Cohall, "Comparison of Three Theoretical Models of Substance Abuse Among Urban Minority High School Students," *Journal of the American Academy of Child and Adolescent Psychiatry*, Vol. 32 (1993), pp. 975–981.
7. Gary W. Ladd, "Having Friends, Keeping Friends, Making Friends, and Being Liked by Peers in the Classroom: Predictors of Children's Early School Adjustment?" *Child Development*, Vol. 61 (1990), pp. 1081–1100.
8. Many childhood social interactions are reminiscent of the popular book by Robert Fulghum, *All I Really Need to Know I Learned in Kindergarten* (New York: Ballantine Books, 1993).
9. Duane Buhrmester, "Intimacy of Friendship, Interpersonal Competence, and Adjustment During Preadolescence and Adolescence," *Child Development*, Vol. 61 (1990), pp. 1101–1111.
10. Kathryn Wentzel and Kathryn Caldwell, "Friendships, Peer Acceptance, and Group Membership: Relations to Academic Achievement in Middle School," *Child Development*, Vol. 68 (1997), pp. 1198–1209.
11. Frédéric Guay, Michel Boivin, and Ernest V. E. Hodges, "Social Comparison Processes and Academic Achievement: The Dependence of the Development of Self-Evaluations on Friends Performance," *Journal of Educational Psychology*, Vol. 91 (1999), pp. 564–568.
12. See, for example, T. J. Berndt and G. W. Ladd, *Peer Relationships in Child Development* (New York: Wiley, 1989).
13. Steinberg, *Beyond the Classroom: Why School Reform Has Failed*, pp. 158–159.
14. Signithia Forham and John Ogbu, "Black Students' School Success: Coping with the Burden of 'Acting White'," *Urban Review*, Vol. 18 (1986), pp. 176–206.

demic and career achievement between whites and minorities.[15]

In summary, the literature suggests that peer effects become strongest by early adolescence. Further, the literature indicates that peers significantly influence all facets of a child's life, including academic achievement. The model specified below explores both of these issues, in particular the effect of peers over time and the denigration of academic achievement by peers.

## DATA CHARACTERISTICS

The 1998 NAEP database on reading was used to test the influences of peer attitudes on academic achievement. The NAEP, first administered in 1969, is an examination that measures academic achievement in a variety of fields, such as reading, writing, mathematics, science, geography, civics, and the arts. Currently, the NAEP is administered to fourth, eighth, and 12th grade students with the main subjects of math and reading alternating every two years. In 1998, for example, reading was tested; in 1996 and 2000, math was assessed.

The NAEP is actually two tests: a nationally administered test and state-administered tests. Over 40 states participate in the separate state samples used to gauge achievement within those individual jurisdictions. For purposes of this study, only the 1998 national data were used.

The most significant benefit of using the NAEP data is the assortment of background questions asked of the students taking the exam, as well as of their main subject-area teacher and school administrator. The responses gathered from the teachers and school administrators are linked to the student information, yielding a rich database of information. Questions are asked on a variety of topics, including:

- TV viewing;
- Computer usage at home and school;
- Teacher tenure and certification;
- Socioeconomic status;
- Basic demographics; and
- School characteristics.

By having these questions incorporated, researchers have been able to glean a great deal of information relevant to explaining the differences in NAEP scores.

## THE HERITAGE MODEL

The purpose of this study is to explain academic achievement by analyzing six factors: the effect of peers, race and ethnicity, parents' educational attainment, number of reading materials in the home, free or reduced price lunch participation, and gender. Using regression analysis, the effect of each factor can be isolated. The Heritage model uses a jackknifed ordinary least squares model[16] and looks at the effects of these factors on the NAEP 1998 reading test's nationwide sample of public school children.[17]

### Independent Variables

1. **Peer Effect.** The 1998 NAEP asked a most interesting question to gauge the effect of peers on academic achievement. The survey asked the child to strongly agree, agree, disagree, or strongly disagree with the following statement: "My friends make fun of people who try to do well in school."

   This question is particularly useful in measur-

15. The statistics on the white–minority gap in academic achievement have been well documented recently by Elaine Bell Kaplan, "'It's Going Good' Inner-City Black and Latino Adolescents' Perceptions About Achieving an Education," *Urban Education*, Vol. 34 (1999), pp. 181–213.
16. Ordinary least squares is a general statistical regression technique that is often used by researchers. See Michael Lewis-Beck, *Applied Regression: An Introduction* (Beverly Hills, Cal.: Sage Publications, 1980); from Sage Publications' *Quantitative Applications in the Social Sciences*, Series No. 07–022. A jackknife is a complex resampling technique that is designed to accurately estimate statistical significance from data in surveys such as the NAEP that employ a complex sampling methodology. See Appendix A for the results and a more complete discussion of the jackknifed ordinary least squares model.
17. Private school children are excluded from this analysis.

ing the effect of peers on academic achievement. First, it focuses on the group of children with which the sampled child most closely associates. Second, it does not ask whether the child's friends make fun of him or her, which would be more likely to elicit a defensive or otherwise inaccurate answer ("My friends do not make fun of *me*").

It is important to note that this model considers the peer effect variable simultaneously with the racial demographics variable, isolating the effect of each on academic achievement. Table 1 reports the proportion of children by race/ethnicity who answer "agree" or "strongly agree" to the peer effect statement. White fourth grade students are much less likely to agree with the peer effect statement than non-white fourth grade students; however, the disparity of responses between white and non-white students narrows significantly for eighth graders.

2. **Race and Ethnicity.** Many studies and reports have demonstrated that African–American and Latino students tend to do worse on standardized tests than white students over time (although the gap has generally narrowed over the past 25 years).[18] There are a number of potential explanations for this.[19] Because strong differences exist in academic achievement among the races, the model includes race and ethnicity variables.

3. **Parents' Education.** Many researchers have noted that the educational attainment of a child's parents is a good predictor of the academic achievement of the child. Parents who are, for instance, college educated could be better equipped to help children with their homework and the understanding of concepts than those with less than a high school education, other things being equal. Because the education level of one parent is often highly correlated with that of the other, only a single variable is included in the model below.

4. **Number of Reading Materials in the Home.** The existence of books, magazines, encyclopedias, and newspapers is often a sign of a dedication to learning in the household. Researchers have determined that these reading materials are important aspects of the overall home environment.[20] The model thus includes a variable controlling for the number of the four types of reading materials found at home.

5. **Free/Reduced Price Lunch Participation.** Income is often a key predictor of academic achievement because low-income families seldom have the resources to purchase extra study materials or tutorial classes that may help their children do better in school. The NAEP does not collect data on household income but does collect data on participation in the school's free and reduced price lunch program, which are the data used here.[21]

6. **Gender.** Research has suggested that on an empirical level, girls perform better on reading and writing subjects while boys perform better on the more analytical subjects of math and science.[22] Many authors have expounded on this idea,[23] yet the data on the male–female achievement gap are often inconsistent. For

18. For an analysis of the long-term achievement gap, see U.S. Department of Education, *Report in Brief: NAEP 1996 Trends in Academic Progress* (Washington, D.C.: U.S. Government Printing Office, 1997), Figure 2, p. 14.
19. For one recent compilation on this subject, see Christopher Jencks and Meredith Phillips, eds., *The Black–White Test Score Gap* (Washington, D.C.: Brookings Institution Press, 1998).
20. Such opinions have been prevalent for years. See, for example, James S. Coleman, Thomas Hoffer, and Sally Kilgore, *High School Achievement* (New York: Basic Books, 1982).
21. Since eligibility for the free and reduced price lunch program is determined by household income relative to the official poverty line, this variable provides a good proxy for income.
22. U.S. Department of Education, *NAEP 1994 Trends in Academic Progress* (Washington, D.C.: U.S. Government Printing Office, 1996).
23. For a brief discussion of this point of view, see Thomas Hancock *et al.*, "Gender and Developmental Differences in the Academic Study Behaviors of Elementary School Children," *Journal of Experimental Education*, Vol. 65 (1996), pp. 18–39.

example, in 1998 young men scored higher on both the verbal and quantitative sections of the Scholastic Achievement Test (SAT) than young women. Some writers have noted that this may be because of a fundamental bias against females in our educational system.[24] Another explanation, however, is that the test results reflect a selection bias in which more "at-risk" females opt to take the SAT relative to males.[25] In order to account for this issue, the analysis includes a variable for gender.

Table 1 CDA00-06

**Percentage of Students Who Agreed/Strongly Agreed to Statement "My Friends Make Fun of People Who Try to Do Well in School"**

| | Fourth Grade | Eighth Grade |
|---|---|---|
| White | 17.5% | 22.9% |
| African-American | 35.8% | 23.3% |
| Hispanic | 28.8% | [illegible]4% |
| Other | 23.7% | 28.0% |

Source: National Assessment of Educational Progress 1998 National Reading Database.

7. **Omitted variables.** Previous research on peer effects[26] included more family background variables in the model specification. In the 1998 NAEP database, however, the only information available on a child's parents is educational attainment. The NAEP does not ask whether the child lives with both parents (or parental figures), one parent, or no parents (i.e., in a group home). Future administrations of the NAEP test should include this type of question since a great deal of research has found that having both parents in the home can improve a child's academic achievement.

## RESULTS OF THE ANALYSIS

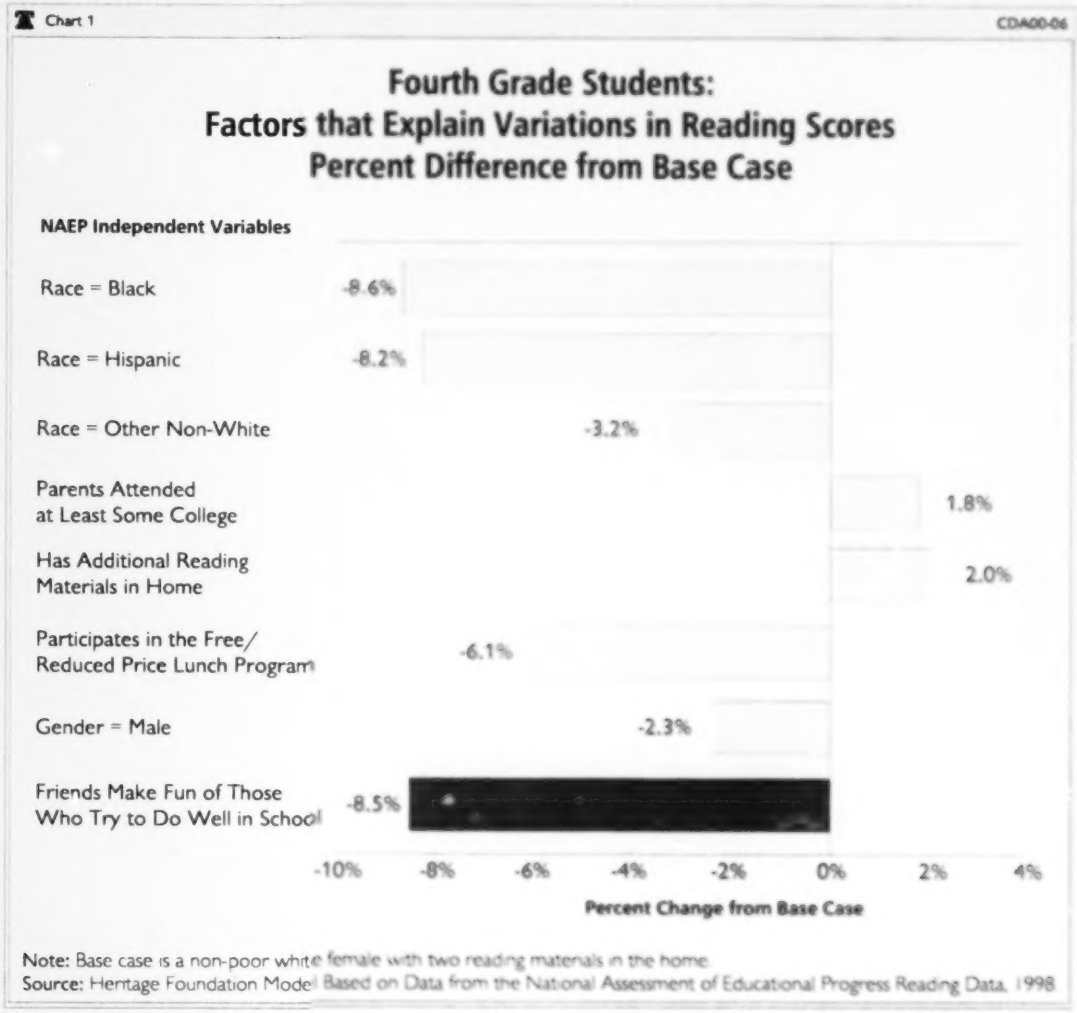
Analysis of the data shows that the peer effect is a strong influence on academic achievement, particularly at the fourth grade level. Family background characteristics have a similarly important influence. Both the peer effect and family background have effects that are independent from the effects of gender and race and ethnicity.

Charts 1 and 2 show the percent change in fourth and eighth grade[27] reading scores attributable to the factors in the model, compared with a base case.[28] The base case is defined as a child with the following characteristics:

- Female;
- Non-poor (i.e., not participating in the free and reduced price lunch program);
- Parents who did not attend college; and
- Has two out of the four possible reading materials in the home.

A female child who is not poor (meaning the child is not participating in the free and reduced price lunch program), whose parents did not attend college, and who has two out of the four possible reading materials in the home would

24. See Myra and David Sadker, *Failing at Fairness: How America's Schools Cheat Girls* (New York: Simon & Schuster, 1994).
25. The College Board, *1999 College Bound Seniors* (New York: The College Board, 1999).
26. See, for example, Kirk A. Johnson, "Comparing Math Scores of Black Students in D.C.'s Public and Catholic Schools," Heritage Foundation *Center for Data Analysis Report* No. CDA99–08, October 7, 1999.
27. Although the NAEP exam is administered to 12th graders as well as fourth and eighth graders, the background questionnaire is much less extensive for the 12th graders. Thus, this analysis may be completed only for the fourth and eighth grades.
28. The base case within a regression model is generally arbitrary. Changing the base model case does not change the interpretation of the results.




score 227.6 points on the NAEP (out of a maximum of 500) if she is in the fourth grade, or 260.5 points if she is in the eighth grade. If she were poor, black, Hispanic, or male, her score would drop on average, while if her home had more than two reading materials, or if her parents had taken any college-level courses, her score would increase.

## Peer Effects

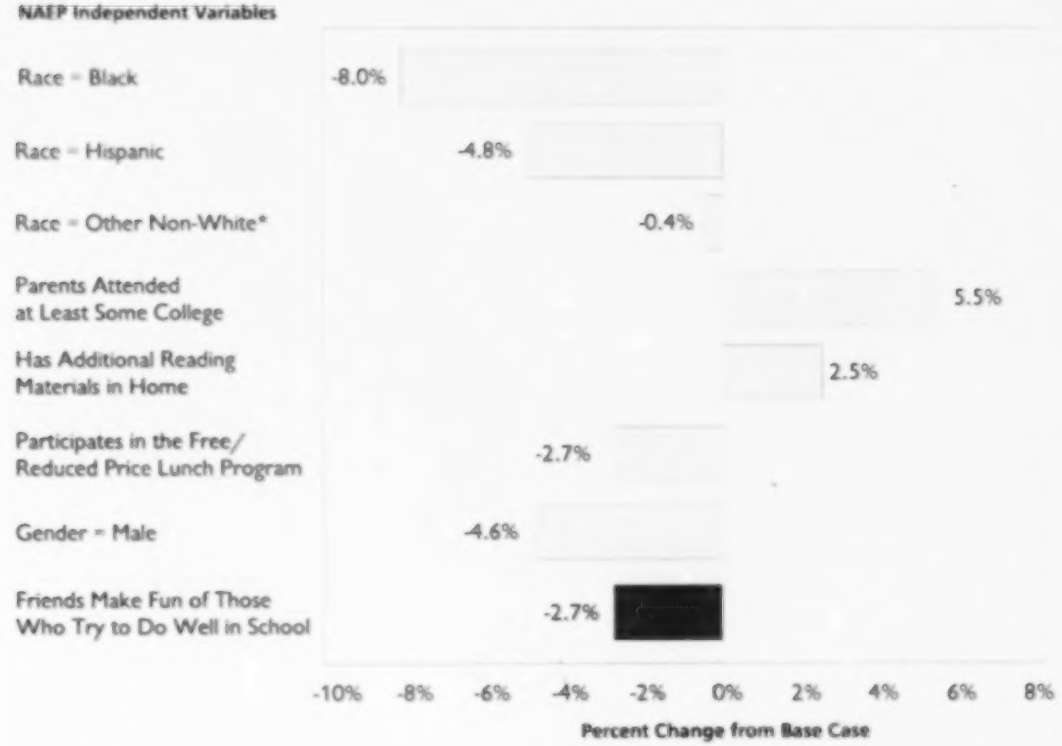
Perhaps the most interesting result is that the peer variable has as large an effect as the racial demographics variables for fourth graders. The typical fourth grader would see her score drop some 19 points, or just under 8.5 percent, if her peers made fun of academic achievers. This result is independent of the effect of the other factors in the model, including race, income, parental education, home reading materials, and gender. For the typical eighth grader, NAEP scores drop by only about 2.7 percent, making the variable relatively weaker in explaining differences in reading achievement.

This relative drop in the peer effect variable from the fourth to the eighth grade (from 8.5 percent to 2.7 percent) is surprising in light of other education research. For example, one researcher argues that peer pressure influences tend to peak between the eighth and ninth grades.[29] This analysis leads

29. Steinberg, *Beyond the Classroom: Why School Reform Has Failed*, pp. 141–142.

Chart 2 CDA00-06

**Eighth Grade Students:**
**Factors that Explain Variations in Reading Scores**
**Percent Difference from Base Case**




Note: * Not statistically significant. Base case is a non-poor white female with two reading materials in the home.
Source: Heritage Foundation Model Based on Data from the National Assessment of Educational Progress Reading Data, 1998

to the expectation that the achievement gap should widen, not collapse, as a result of the peer effect between the fourth and eighth grades.

There are two possible explanations for the diminishing peer effects. First, older students may mask their academic achievement from their friends. That is, peers do not necessarily know exactly what grades their friends achieve or how much time they spend on homework in any given week. Thus, individual students may be able to give their peers a false impression of their academic performance, especially as they reach adolescence. Although peer pressure could generally increase, students may be able to avoid academic pressure more easily.

Second, adolescent peer pressure may focus on extracurricular behavior rather than on classroom behavior. In other words, as children test their independence, they may focus negative peer pressure on antisocial behavior outside of school rather than on academic achievement. For example, social experimentation with cigarettes, alcohol, and other illicit substances generally begins in junior high. The attention paid to this kind of peer pressure may supersede pressure regarding grades in class. Thus, the results seen in this model may actually be consistent with other studies of peer pressure.

### Other Results

Another interesting result is the effect of the parents' education on the child's achievement. The eighth graders' rise in reading test scores is much more pronounced than the fourth graders' increase. This is consistent with most researchers' expectations. As children progress to higher grades, concepts within the subject become more involved. After mastering basic concepts (such as rudimentary literacy, word forms, subject/verb conjugations), children begin to tackle higher-level thinking skills (logic, describing themes from stories, and so forth). Therefore, parents with college experience may be better equipped to help their children with their homework and school achievement as their children progress in school.

In addition, both fourth and eighth grade girls score slightly higher than boys on the reading exam, which bolsters recent evidence that girls have a number of advantages in school over boys. Girls on average "get better grades, are more engaged academically, and are now the majority sex in higher education."[30] Despite the popular idea that schools shortchange girls, the results here do not support this notion.[31]

Finally, it is important to note that throughout the academic literature on education, poor and minority students continue to have persistent challenges in academic achievement. This report's conclusions are consistent with this finding.

## CONCLUSION

This analysis demonstrates the significant effect of peer attitudes toward academic achievement on America's public school students' reading achievement. Using the 1998 National Assessment of Educational Progress database, the study found that the peer effect is one of the largest determinants of academic achievement in reading for the fourth grade.

The significance of the peer effect, however, wanes in importance by the eighth grade. This result seems inconsistent with other literature that suggests the peer effect should be at or near its apex by the eighth grade. By the eighth grade, however, pressure on social behaviors may be more important than pressure on academic achievement.

*—Kirk A. Johnson, Ph.D., is a Policy Analyst in the Center for Data Analysis at The Heritage Foundation.*

30. Christina Hoff Summers, "The War Against Boys," *The Atlantic Monthly*, Vol. 285 (May 2000), p. 60.
31. See, for example, American Association of University Women, ed., *Gender Gaps: Where Schools Still Fail Our Children* (New York: Marlowe & Co., 1998).

## APPENDIX A: RESULTS OF THE STATISTICAL MODELS

The results of the fourth and eighth grade models are found in Table 2. As the results show, the model variables are statistically significant,[32] with the exception of the "race = other non-white" variable in the eighth grade model.[33] One of the most important factors, then, is the peer effect or "make fun of" variable in the fourth grade model. For fourth graders, the peer effect variable has one of the largest effects on academic outcomes of the variables tested.

In this analysis, there are two statistical issues to confront. First, the NAEP examination is a long test and therefore is not administered in its entirety to all children. Rather, different parts are given to different children. Certain students will do better on certain portions of the test than others. Consequently, a "true" score must be estimated, or imputed, from the incomplete information. The NAEP estimates five plausible composite reading scores and recommends that researchers use all five in any analysis. The Heritage model here follows the guidelines specified by the Educational Testing Service (which works closely with the National Center for Education Statistics in developing the file) for incorporating all five reading scores into the analysis.[34]

Second, the NAEP utilizes a complex sample design that oversamples children with certain characteristics.[35] As a result, each child has a

Table 2 CDA00-06

### Regression Analysis of NAEP Reading Achievement for Public School Students Nationwide

**Fourth Grade Reading Score Model: Effects of Independent Variables on Reading Score**

| | Coefficient | T-Test | Significance |
|---|---|---|---|
| (Constant)* | 218.322 | 93.213 | 0.0000 |
| Race = Black | -19.668 | -11.683 | 0.0000 |
| Race = Hispanic | -18.750 | -9.549 | 0.0000 |
| Race = Other Non-White | -7.242 | -2.880 | 0.0040 |
| Parents Attended at Least Some College | 4.112 | 2.759 | 0.0058 |
| Has Additional Reading Materials in Home | 4.649 | 6.487 | 0.0000 |
| Participates in the Free/Reduced Price Lunch Program | -13.866 | -9.632 | 0.0000 |
| Gender = Male | -5.159 | -4.738 | 0.0000 |
| Friends Make Fun of Those Who Try to Do Well in School | -19.305 | -12.259 | 0.0000 |
| Explanatory Power: $R^2 = 0.2791$ | | | |

**Eighth Grade Reading Score Model: Effects of Independent Variables on Reading Score**

| | Coefficient | T-Test | Significance |
|---|---|---|---|
| (Constant)* | 247.239 | 130.201 | 0.0000 |
| Race = Black | -20.968 | -13.454 | 0.0000 |
| Race = Hispanic | -12.623 | -6.811 | 0.0000 |
| Race = Other Non-White | -1.101 | -0.505 | 0.6134 |
| Parents Attended at Least Some College | 14.256 | 12.103 | 0.0000 |
| Has Additional Reading Materials in Home | 6.620 | 12.032 | 0.0000 |
| Participates in the Free/Reduced Price Lunch Program | -6.994 | -5.961 | 0.0000 |
| Gender = Male | -12.103 | -12.521 | 0.0000 |
| Friends Make Fun of Those Who Try to Do Well in School | -7.003 | -6.424 | 0.0000 |
| Explanatory Power: $R^2 = 0.2907$ | | | |

Note: * The "constant" term refers to the reading score value when all other model variables are set to zero. Coefficients represent changes above or below the average (mean) score per unit of the independent variable.
Source: Data are from the 1998 National Assessment of Educational Progress Reading Exam.

32. Usually pegged at a 5 percent or 10 percent level. See Lewis-Beck, *Applied Regression: An Introduction*.
33. The coefficient value of this variable, or its effect on academic achievement, is not statistically different from zero, so it has no effect.
34. From a multivariate regression perspective, the model specified must be replicated five times, using each of the plausible values individually and then averaging the resulting coefficients to yield the final model results. In technical terms, this process corrects for measurement error in the reading score variable since the test administrators do not actually observe the test score from taking the exam in its entirety.
35. For example, the NAEP typically oversamples for race and the geography of the school attended (e.g., urban or rural).

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unique weight assigned to him or her that is calculated from the probability of being selected from the population at large (in this case, from the U.S. population of fourth or eighth graders in public schools). The NAEP's sample design requires a complex modeling technique, which the Heritage model employs.[36]

36. A procedure called a jackknife must be employed to correctly assess the variance of each variable's coefficient, and the NAEP database has a series of 62 "replicate weights" to aid in this task. These 62 jackknifes must be applied and the variances of each coefficient averaged for each of the five plausible test score models (yielding a total of 315 models compiled for the purpose of this research). The WesVar Complex Samples software (produced by Westat) did much of this replication work. Using the jackknife results with the five plausible values models allows for a variance correction mechanism. The purpose of the jackknife is to estimate a true sampling error. Correcting for the two types of error (measurement and sampling) allows for the most accurate estimates possible. See Bradley Efron, *The Jackknife, the Bootstrap, and Other Resampling Plans* (Philadelphia: Society for Industrial and Applied Mathematics, 1982), and Jun Shao and Dongsheng Tu, *The Jackknife and Bootstrap* (New York: Springer Verlag, 1995), for a more complete discussion of how this jackknife technique works.

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